Retinopathy Detection using Retinal Fundus Images among Suspected Individuals

SHORT SYNOPSIS

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To

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Certificate

I hereby declare that the short synopsis "Retinopathy Detection using Retinal Fundus Images among Suspected Individuals" being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in Computer Science under the faculty of Engineering and Technology of Manav Rachna International Institute of Research & Studies, Faridabad during the academic year 2021.

It is a bonafide record of original work carried out under the supervision of **Dr. Charu Virmani** and has not been submitted in full or part to any other university or institute for a degree or diploma. Further, it is certified that the short synopsis is plagiarism-free and the proof has been submitted.

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Abstract

Retinopathy is fast spreading eye disease and this may lead to blindness in working age. Between 32 to 40 % of about 246 million people suffering from eye disease. This happens when the blood vessels within the retinal area of the human eye become damaged. The damaged blood vessels cause a leak which eventually leads to dark spots in our vision resulting inadequate blood flow, hypoxia, and neuron degeneration. It is a silent vision problem and thus, requires regular annual check-ups as initial control and effective treatment provides favorable results. Deep learning is rapidly improving, and it is gradually becoming an efficient technique for giving an interesting solution to image analysis problems.The study adopts a deep learning framework for the retinopathy classification eye images which will aid in addressing the future problem. Numerous advanced studies on the identification or detection of retinopathy have recently been published.The study aims to investigate automatic methods for detection of this disease and thereafter an effective system can be developed for diagnosis and screening of retinopathy. An automation technique would assist the clinicians to diagnose this disease at an early stage for effective treatment. Thus, early detection by using the proposed technique can combat this worldwide problem.

Keywords*:* Deep Learning, Eye Disease, Retinal Images, Retinopathy.

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1. Introduction to Retinopathy

As the socioeconomic status and life expectancy increases, a lot of countries across the globe have more people living as adults, an increase in average population age, and a shift of morbidity to non-communicable diseases and disabilities.Visual impairment or vision loss has a severe impact on the standard of living of adult populations.Visually impaired adults often have lower labor market production rates and increased theintensity of dejection and anxiety. When it comes to older adults, visual impairment and blindness advance to lack of contact, abnormal gait, a greater chance of falls and broken bones, and a higher probability of early entry to care homes.

Population aging has resulted in an increasing number of vision impairment people suffering from moderate or more severe visual impairment worldwide. The reasons for vision loss in children vary considerably from country to country. Thus, in lower-class countries, cataracts and diabetic retinopathy are the primary causes, whereas, in working-class countries, retinopathy of prematurity is the main cause. Uncorrected refractive error and Hypertensive retinopathy remain a leading cause of vision impairment in adult populations all around. In Nilo-Saharan region and South Asia, for example, the amount of blind people is over eight times higher than in high-income countries. It disproportionately affects seniors, rural communities, ethnic minorities, and indigenous peoples.

Eye conditions such as near or farsightedness, glaucoma, and cataracts may be left to worsen in areas where people lack access to regular checkups, treatment, and care, making daily life unnecessarily difficult. Those who require eye care should be able to access it without suffering financial hardship.Trachoma, Acute Glaucoma, Age-related Macular Degeneration (AMD), Vitamin A deficiency, Cortical Cataract, Hypertensive Retinopathy, Retinopathy of Prematurity and retinopathy due to diabetes are the top causes of chronic blindness. Age-related blindness is on the rise worldwide, along with blindness caused by uncontrolled diabetes.

Around the world, more than 2.2 billion population are visually impaired, and more than a billion are forced to live in unpreventable or unavoidable conditions simply because they cannot access the support they needed. Vision loss could have been prevented or remains untreated in at least 1 billion or almost half of these cases. In 2020, the following will be the main causes of sightlessness in people over the age of fifty (Lancet Global Health, 2020). 15.2 million cases of Cortical Cataract, 3•6 million cases of Acute Glaucoma, 2.3 million cases of Refractive Error, 1.8 million cases of Age-related Macular Degeneration (AMD), and 0.86 million cases of Diabetic Retinopathy as shown in Figure 1.

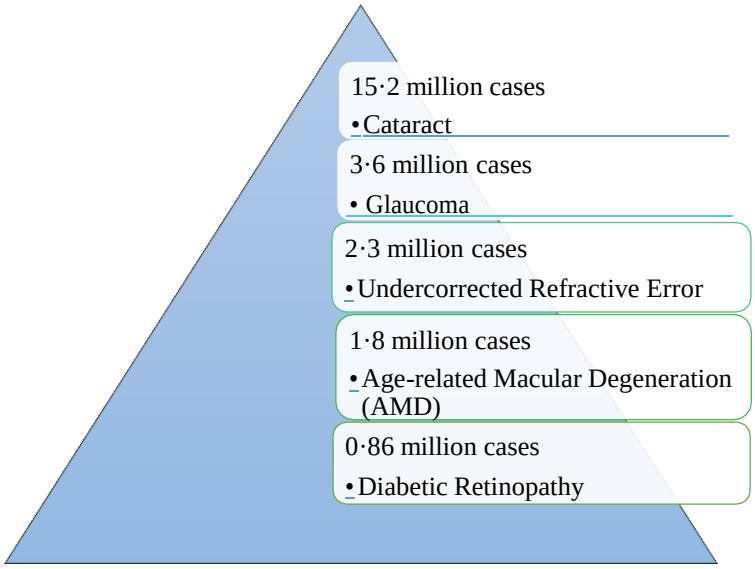

Figure 1: Leading cause of blindness in 2020

One of the most severe eye conditions is Diabetic Retinopathy, as well as the most frequent retinal disease. It is the major reason for vision loss among people globally. Also, Table 1 shows the distribution of sight-impaired persons in the six World Health Organization (WHO) regions , with the

Table 1: Distribution of sight-impaired persons in the six WHO regions(WHO, 2021)

List of WHO Regions	Total Population(in million)	Blind(in million)	Vision Impairment (in million)	Poor Vision or Blury Vision(in million)
African Region (AFR)	804.9	5.9	20.4	26.29
Region of the Americas (AMR)	915	3.2	23.5	26.6
South-East Asian Region(SEAR) (excluded India)	579	3.9	23.9	27.9
European Region (EUR)	889	2.7	25.5	28.2
Eastern Mediterranean Region (EMR)	580	4.9	18.5	23.4
India	1181.4	8.075	54.544	62.6

number of overall impairments (in million).

Diabetic eye disease is a vision problem that diabetic patients may experience because of their diabetes, and all may result in severe impaired vision. It may contain Diabetic Retinopathy, Cataract, and Glaucoma. Cataracts are like a cloud zone that develops inside the eye and can affect one or both eyes and occur because of aging, trauma, or exposure to radiation. Glaucoma is a vision condition caused by abnormally high pressure inside the retina, causing damage to the optic nerve and loss of vision. Diabetes sufferers are almost double as likely as other adults to develop glaucoma. Diabetic retinopathy is a complication of diabetes due to damage to blood vessels in the back of the eye. Various risk factors include diabetes, smoking, hypertension, high levels of cholesterol, and poor blood sugar monitoring. It affects the eyesight of over half of the eighteen million diabetic population aged 18 and over (Lancet Global Health, 2020). Patients with diabetes should have a full annual dilatation vision screening.

However, diagnosis of a retinopathy disease is very challenging at the early stages as the symptoms are very less and undetectable. Therefore, early screening and diagnosis were determined as one of the method to reduce the rate of blindness due to diabetes. With increased focus on routine medical checks and the use of special equipment's for the disease detection the impact on health staff cannot be overestimated. It has resulted in increased workload on human resources, but also increased diabetes screening activities, to name a few.

Many techniques were developed and improved to alleviate the stress caused by this routine check-up and screening activities. One example is the use of medical image processing for retinal disease diagnosis.

Several Ocular retinal diseases, including Diabetic Retinopathy, Acute Glaucoma, and Age-related macular degeneration (AMD), have undergone extensive clinical research because they are the primary causes of vision loss. Ophthalmologists use different types of imaging systems, such as anterior segment Optical Coherence Tomography (OCT), background photography, and angiography, to deal with retinal diseases.

Manually reviewing medical images takes time, so developing automated image analysis systems is an important task. Retinal image analyses, such as segmentation, localization, identification, classification, etc., provide critical information about the quality of the vision system by detecting disease risk or damage. Designing interactive and automated systems can essentially fulfill the automated analysis of images.

Automated methods are considered desirable to facilitate, replace or accelerate the diagnostic process. These automated methods offer greater benefits than others algorithms.Its result proves that the retinopathy classification system can be established with fundus images of the eye.The time required to perform manual analysis of this disease by using some automated methods will be the same.

In deep learning when it comes to analyzing and interpreting medical imaging, Convolutional Neural Network (ConvNet or CNN), a type of Deep Neural Network (DNN) has a proven track record. CNN has learned very abstract features in training images using labeled data, which is then used to construct a classification model (S. Albawi, T. A. Mohammed, and S. Al-Zawi, 2017).This type of deep learning or in-depth learning is used to solve image classification problems or problems involving large amounts of labelled image data. Following that, the CNN will be trained to diagnose retinopathy based on the classification.

The trained CNN can then produce predictions for novel images. It can be used to produce an initial response to a patient at the point of care without the need for a qualified ophthalmologist once they have been trained to a high level of precision. As a result, any technique used in clinical diagnosis necessitates some clarification of the diagnosis's cause. The work will introduce several approaches to the issue. A sample image received through a screening program that requires diagnosis shown in Figure 2.

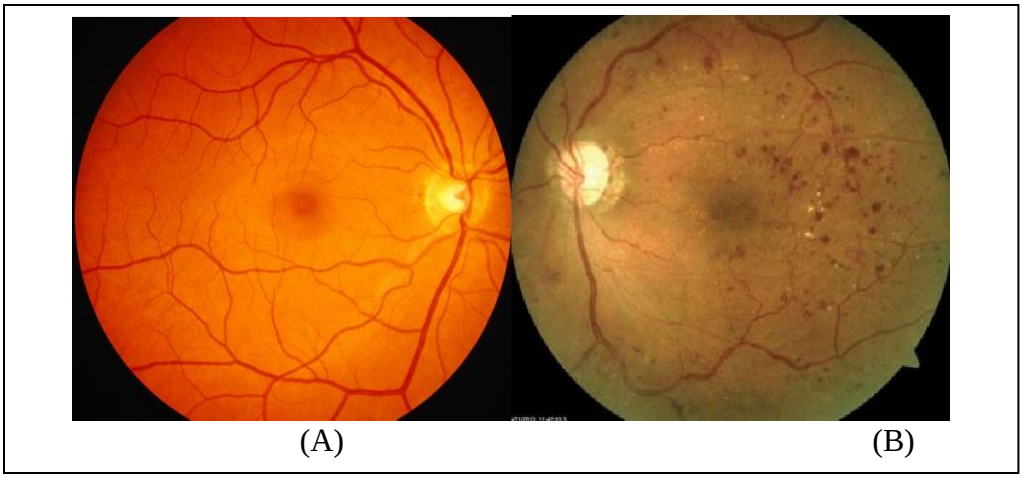

Figure 2: (A) Normal Retina of the right eye (B) Abnormal Retina of the left eye

The closest a trait gets to the macula, the more it contributes to the disease severity classification.

Thus, various deep learning approaches have been applied to detect retinopathy disease which results in a complex classification task that involves several issues.

1.1 Development of Deep Learning for Image Classification

This section describes the process of classification of images according to the processes involved in this concept and the multiplicity of image editing that uses an in-depth reading supervised learning framework. Supervised learning means methods that involve using labeled data (Rahulkar, A.D., Randive, S.N., and Senapati, R.K., 2020). The training/testing procedures are described in Figure 3.

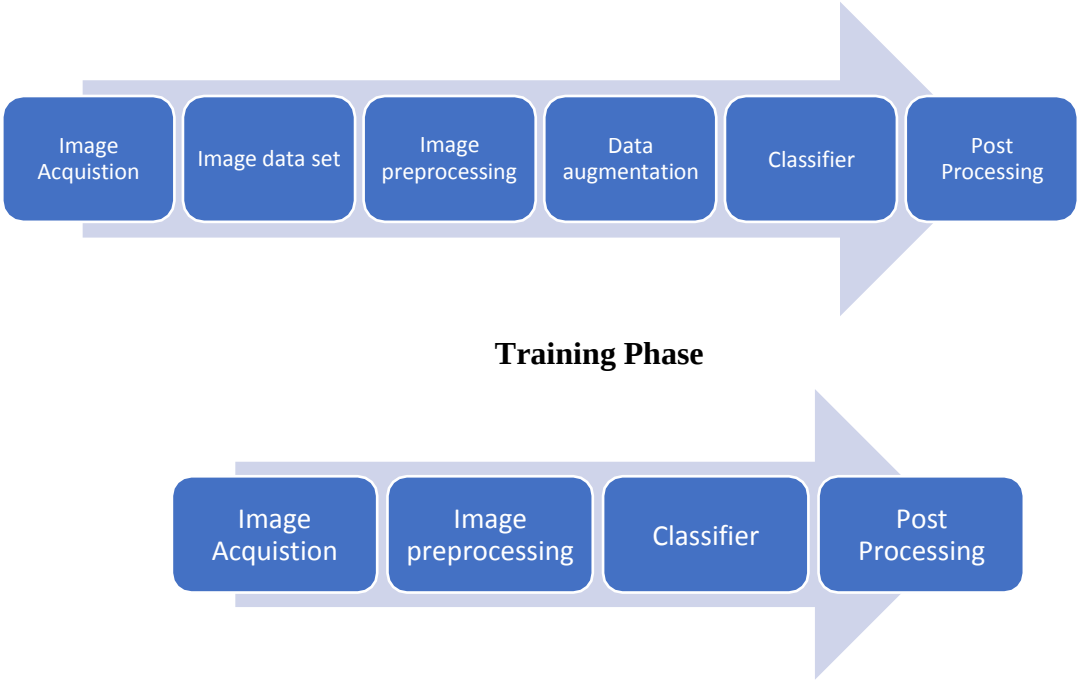

Figure 3: The training stage and the validation stage

The phases are divided into three stages: data collection, pre-processing, and augmentation. In the training/testing process, the idea of a classifier is to feed it some data. Once the classifier has been properly trained, it can be used to detect any disease. Each stage is further explained in the following sections. The image classification technique consists of two different steps, namely training and testing or validating. The principal purpose of the training stage is to train the image classifier to find accurate results. The learned classifier's accuracy is then checked in the validation

stage. It is carried out by classifying pre-labelled test results. If the accuracy/precision of the classifier is acceptable, the classifier is ready to be deployed for previously missed data.

1.1.1 Data Acquisition

The process for classifying images begins with data collection. The resultant data must be defined using appropriate class labels. As a result, experts in the field are obliged to label the data. Data is stored in image classification, in the proper way to store images to retain the key features or elements needed to classify them. To hold a set of images for verification, they are divided into two groups: a training set and a test set. Normally, about twenty percent of the images are included in the test collection.

1.1.2 Image Pre-processing and Augmentation

Data consists of images derived from real-world data that may be too dark or too bright, they may not be ready for processing. Its goal is to split images by identifying differences in images that are related to features. As a result, reducing any image variations that aren't possible due to image noise is beneficial. This is accomplished by pre-processing the image database to reduce noise and color variation and possibly improve differentiation performance (Lin, J., Yu, L., Weng, Q. and Zheng, X., 2019). A pre-processing step that is directly dependent on the separating function and may involve different color spaces. Converting image data into other image representations is one example of pre-processing.

After a preliminary review, during the training phase, data extensions are carried out. Simple image transitions such as rotation, zoom, rotation, and vertical shifts, among others, are used. Image editing, unlike pre-processing, should not affect segregation issues. This step is not completed on time during the verification phase, because the data used to test the model should be the only modified data pre-processing to determine the model's actual accuracy.

1.1.3 The Classifier

The separator method takes the image as input and returns predicted values as output. In features-based classifiers that are used traditionally, features can be retrievedwithin the images. Classifier gives the outputs during the final point at the time of separation, but usually with lots of restrictions (Krizhevsky, A., Sutskever, I. and Hinton, G.E., 2017). The separator is generally

trained, during the training phase by examining the values that are predicted from the set of trained images. To improve the performance of the set of images, parameters are updated on a regular basis, and the procedure was carried out with the help of a function called separation function, which does not reduce data. In the verification phase, the separator does not change and it is only used to retrieve the predicted values from the data entered by the user.

1.1.4 Classifier Interpretation (Post-Processing)

One or more predictor values relevant to diagnosis classes are included in the performance of a deep learning classifier. These expected values are typically in the range of 0 to 1. Interpreting a classifier means that the process of training, assessing, and validating a classifier based on the classifier's outcome.

The classifier output is evaluated in the training stage in the form of a loss function based on the prediction, and then improves and refine the classifier by using an optimization technique. By comparing training images and predictable values, the model can be improved to boost prediction accuracy in the next set of images. The goal is for the separator to learn the characteristics of images that correspond to the classification (S. Albawi, T. A. Mohammed, and S. Al-Zawi, 2017).In verification phase translation; it takes a prediction as including determining the final phase prediction. For example, methods of interpreting divisions during the verification phase may determine phase forecasts based on the highest predictive value, may limit predictive values or may take a combination of dividend predictions to clarify the predicted phase (S. Albawi, T. A. Mohammed, and S. Al-Zawi, 2017).

2. Literature Review

With the increased use of image analysis techniques for retinopathy screening, work has been done to update some existing methods, whereas new methods were also introduced to improve precision, sensitivity and specificity. Accuracy refers to the number of accurately predicted fundus images out of all the fundus images while sensitivity refers to the percentage of the test correctly identified those with retinopathy (true positive rate) and specificity can be termed as the capability to correctly identify those without retinopathy (true negative rate). The higher the three factors, the better the approach is. However, not much work has been done in detecting Microaneurysms and

exudates; most of the research has focused on detecting vascular abnormalities using retinal images. In the literature review, some of this previous work is taken into consideration, and outcomes are also discussed. There are various approaches, in literature, which focused on retinal fundus images for the diagnosis of retinopathy related disease.

The first attempt to detect the blood vessels from the retinal images was designed by (Narkthewan, A. and Maneerat, N., 2019). The study was done by analyzing a total of 40 images for performance evaluation. The results that were concluded were average specificity of 0.6392, the sensitivity of 0.9920, and accuracy of 0.9617. An accuracy of 96.17% was also recorded when the proposed method was applied for the diagnosis of Diabetic Retinopathy (DR).

(Sakaguchi, A., Wu, R. and Kamata, S., 2019) used graph neural network approach for extracting lesion region of retinal fundus images.The author categorized the severity of diabetes retinopathy into five levels. The experiment was done using Indian Diabetic Retinopathy Image Dataset (IDRiD)with variable extraction conditions which consisted of a total of 6 data sets. When the results of datasets 1 and 2 were compared, second dataset had higher accuracy, which was increased by 2.9 percent.The obstacle was to improve a pre-processing method. 79.3% was the highest which was recorded.

(Chowhan, S.S., Deore, R.S. and Naik, S.A., 2019) assessed the segmentation of blood vessels of Non-Proliferative Diabetic Retinopathy (NPDR) using the Digital Retinal Images for Vessel Extraction (DRIVE) dataset. The dilating, rupture, or leak of small retinal blood vessels is caused by structural damage to it, and hence NPDR is characterized. The morphological procedure was done for the segmentation of blood vessels from retinal images. These are present in the segmental arteries of NPDR on which this study mostly focuses.

(Suriyasekeran, K., Santhanamahalingam, S. and Duraisamy, M., 2020) has mentioned the survey of techniques for automated detection of Diabetic Retinopathy (DR) and Diabetic Macular Edema (DME). The two phases are:

(a) Detection of DME

(b) Diagnosis of DR.

Retinal images can be used to identify abnormalities. The main purpose of this research article is to identify and segment key baseline indicators of retinal disease. It involves extracting multiple

features and their classification according to their severity level. The focus of this study is mainly on dark and bright lesions of various shapes and their sizes for the detection of exudates for the detection of DME.

According to the study of (Akram, M.U., Khalid, S. and Khan, S.A., 2013) to detect Microaneurysms (MA) at the earliest, a three-stage system using filter banks is proposed in this article. At first, all possible MA candidate regions present in retinal images are extracted. A system has developed those aids in classifying a candidate region as MA or Non-MA based on properties such as shape, color, intensity, and statistics.To improve the accuracy of classification, a hybrid classifier was combined with different models like a Gaussian mixture model, Support Vector Machine (SVM), and an expansion of the multimodal modeling approach.

The study of (Ram, K., Joshi, G.D. and Sivaswamy, J., 2011) for the automatic Microaneurysms (MA) detection of digital color fundus image, a new approach was presented via this paper. With a lower probability of target occurrence, Microaneurysms detection was framed as a target detection issue from clutter.To decrease the number of clutter responses, a follow-up release strategy was proposed.Using a range of highly differentiated features, the greater number of MA were passed while the specific classes of clutter were rejected which were achieved by designing processing stages. The true positives remaining after the final rejecter, on its resemblance to positive MA, were assigned a score. After evaluating the approach, the results are shared to highlight the objective of the proposed strategy. Additionally, reduce the number of clutter sub-groups to be addressed to simplify the final step.

In the study of (Lin, J., Yu, L., Weng, Q. and Zheng, X., 2019) a review of automated evaluation of eye image quality for diabetic retinopathy was presented in three stages. Firstly, the schematics and specifications were presented. Following that, a comprehensive evaluation of retinal image quality assessment techniques and methodologies was demonstrated. Finally, challenges and research proposals for the future were presented.

(Azar, A.T. and Balas, V.E., 2013) has mentioned in the study that four retinal abnormalities were located in 100 colors retinal images such as Microaneurysms (MA), Hemorrhages, Exudates, and Cotton wool spots. On 100 retinal images, a new automatic algorithm was applied, using the

threshold method, which revealed an 87 % detection rate of MA and 88% Hemorrhages, while correct classifications for these two were 60% and 94% respectively. For exudates and cotton wool, the correction detection rate was 93 percent and 89 percent, respectively, whereas the minimum distance was 95% and 86% respectively.

(Gulshan, V., Peng, L., Coram, M., Stumpe, M.C., Wu, D., Narayanaswamy, A., Venugopalan, S., Widner, K., Madams, T., Cuadros, J., Kim, R., Raman, R., Nelson, P.C., Mega, J.L. and Webster, D.R., 2016) has mentioned in their study that during the diagnosis of eye image of working-age adults with diabetes the statistical measures were recorded. In the study, the author used two data sets, the EyePACS-1 data set, and the Messidor-2 data set. The first data set includes 4997 people with 9963 eye images and sensitivity was 90.3% and the specificity was 98.1%.The second data set includes 874 people with 1748 eye images and sensitivity was 87.0% and the specificity was 98.5%.

The study by (Almotiri, J., Elleithy, K., and Elleithy, A., 2018) developed a robust hybrid segmentation algorithm for the extraction of three retinal structures with the highest accuracy. The author proposed three datasets: DRIVE and Structured Analysis of the Retina (STARE) for vessel detection, DRISHTI-GS for an optic disc, and DIARETDB1 for validation and comparison of pathological retinal images.

The study by (Suriyasekeran, K., Santhanamahalingam, S., and Duraisamy, M., 2020) designed a Neural Network (NN) model for the grouping of normal and abnormal images. The dataset used by the author consists of 767 retinal images,out of which 484 were normal and 283 eye images with diabetic retinopathy. Consequently, the recorded sensitivity was 80.2% and specificity was 70.66%. The model's output was highly accurate in detecting Diabetic Retinopathy.

(Carrera, E.V., Gonzalez, A. and Carrera, R., 2017) also proposed a supervised method that displays better outcomes than other algorithms.The author has also performed a variety of image processing techniques to assist individuals in detecting diabetic retinopathy using retinal images. This scheme was tested using NPDR to figure out the grade scale at 400 retinal images. The average accuracy, sensitivity, and predictive capacity of this approach were around 85%, 95%, and 94%, respectively,for diabetic retinopathy detection of the retinal images.

(T. Shanthi and R. Sabeenian, 2019) recognized the Diabetic Retinopathy (DR) phases of the Messidor dataset utilizing a pre-trained engineering Alexnet. The pictures were resized, and the green channel was removed before being taken care of by CNN. This CNN accomplished a precision of 96.35. Tragically, the work doesn't identify the sores in the pictures and only one dataset and engineering were utilized to test their technique.

(Tsao, H.-Y., Chan, P.-Y. Su and E.C.-Y., 2018) proposed a prediction model to predict diabetic Retinopathy in type-2 diabetes mellitus using various techniques. The experimental result shows that SVM can perform better as compared to other data mining techniques and achieved 79.5% accuracy and the value of area under curve was 0.839 respectively.

(Dai, G., He, W., Xu, L., Pazo, E.E., Lin, T., Liu, S. and Zhang, C.,2020) proposed a deep learning method that can recognize subclinical highlights showing up beneath the limit of a person eyewitness to investigate the impact of hypertension of the retinal microvasculature. A set of 2012 retinal images, 1007 from a dataset with hypertension findings and 1005 from a normotensive control. In this approach, the author trained a CNN classification algorithm, and Grad-CAM was used as a deep learning technique to form a heat map of the specific region in the image. The average accuracy, specificity, precision,and recall of this approach were around 60.94%, 51.54%, 59.27%, and 70.48% respectively.

(Rahulkar, A.D., Randive, S.N. and Senapati, R.K., 2020) proposed a methodology based on a NN classifier to classify eye images into three different levels: feature extraction, classification, and segmentation. The proposed Weighted Probabilistic (WP) analyzes its execution over other traditional techniques regarding exactness, explicitness, affectability, accuracy, and False Discovery Rate (FDR). As a result, it was seen that the exactness of the proposed blend was 4.81%, 10.21%, 11.53%, 12.98%, and 14.47% better from FCM-based Weighted Probabilistic Neural Network (F-WPNN), fuzzy wavelet neural network (F-WNN), and field probing Neural Network (F-PNN), separately. The explicitness of this method was highest as compared to other regular strategies, which was recorded as 2.06%, 3.12%, and 79% respectively.

(D. Zhang, 2017) proposed a ResNet model to detect or classify Diabetic Retinopathy (DR). In the proposed model, three additional sets of layers were added to the moderate layers of the

ResNet to give extra regularization during the cycle. The eyepieces DR training dataset was used. The accuracy rate was 94%, sensitivity rate was 67%, and specificity rate was 81% respectively.

(S. Suriyal, C. Druzgalski, and K. Gautam., 2018) proposes an efficient CNN model for binary Diabetic Retinopathy (DR) screening. This scheme was tested using a retinal image dataset called, the EyePACS DR dataset. An exactness of 0.73 was accomplished by the proposed strategy.

(Alban and T. Gilligan, 2016) suggests that a nonlocal method of noise reduction strategy has been applied to the fundus image to eliminate clamor from the EyePACS DR dataset. AlexNet and GoogleNet were used to characterize the pre-handled retinal pictures. An Area under the ROC Curve (AUC) score of 0.78 is accomplished by the GoogleNet model contrasted with an AUC score of 0.68 accomplished by Alex Net.

In an extensive review of the literature in the area of Retinopathy, some problems have been identified. In the next section, some research gaps, issues identified during the study are explained.

3. Research Gaps

A critical look at the available literature indicates the following issues in the retinal image analysis in the retinopathy detection domain, which needs to be addressed:

- In Retinopathy, all the techniques use a small database for retinal fundus images. The performance of existing algorithms is questionable when they were executed for the enormous size of the information base.
- Image analysis with computer vision is a challenge due to the wide and varied set of fundus images with different patterns and color variations.
- Many techniques exist for the detection of lesions and grading of retinopathy, but they do not consider the identification of all the lesions together.
- For screening of retinopathy, many researchers have applied different classifiers and it is observed that most of the classifiers require larger computation time and many iterations.
- Work on more grades: This could be improved by categorizing retinopathy diseases based on their grades or severity level.

The stated barriers indicate the need for effective image processing and deep learning algorithms to recognize specific patterns from retinal fundus images to classify and detect Retinopathy. The research represents the problem statement undertaken and the objectives of the research. It also emphasizes the research methodology adopted for undertaking this investigation.

4. Description of Broad Area

In the health care field, current advancements in such techniques as image processing and computer vision are specifically aimed at early diagnosis of medical conditions by reducing the required time to prevent vision loss. Significant improvements in image processing have been carried out, such as automatic disease detection like various automated systems have been recommended for the disease detection related to retinopathy. A brief description of the retina, background imaging, and retinopathy can be found below.

4.1 The Retina

The retina is a multi-layered sheet of neurons, photoreceptors, and supporting cells. The retina is a metabolically super active organ in which the exchange of nutrients and gases is performed openly (M. Alban and T. Gilligan ,2016).When light enters the eye, focused on the retina, penetrates the eye, the retina responds by passing them through the optic nerve to the brain. Then, as an image, the brain receives and interprets it. The conceptual view of human eye anatomy as shown in Figure 4.

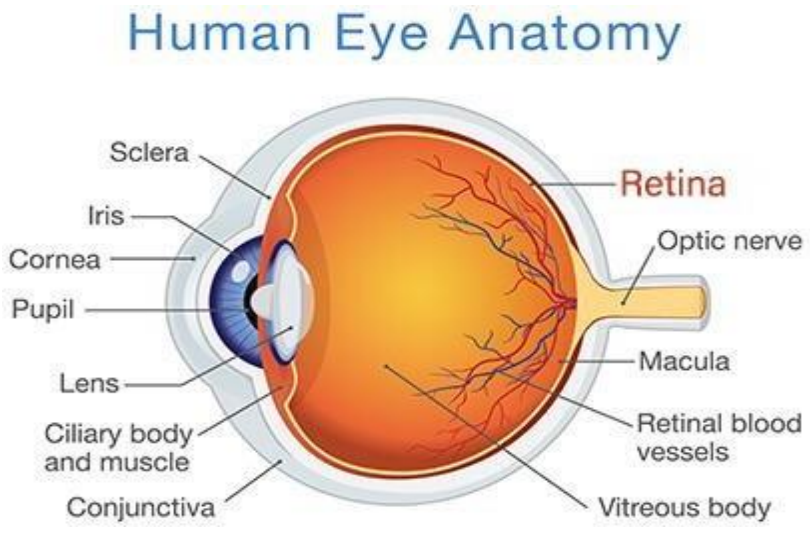

Figure 4: Anatomy of Human eye (M. Alban and T. Gilligan , 2016).

Through two outlets, the eye receives its bloodstream: choriocapillaris and the arteria centralis retinae branches. The first one feeds the outer layer of the eye, whereas the branches of the arteria centralis retinae feed the remaining area of the eye(M. Alban and T. Gilligan, 2016).

4.2 Fundus Photography

To image the internal structures of the human eye, there are numerous medical imaging methods, including fundus photography and Optical Coherent Tomography (OCT). Both of these are non-invasive. The pictures of eye tissue are provided by OCT. Fundus photography, however, provides images of the human eye's internal structures, that includes the fovea, retina, optic disc, macula, and blood vessels (Krizhevsky, A., Sutskever, I. and Hinton, G.E., 2017). OCT is useful when ocular diseases are diagnosed in the tissues. Background images or fundus images, however, are highly effective when eye diseases are diagnosed in the retina. In addition, the faster and more convenient approach is fundus photography. Fundus images are mainly of two types i.e. indexed images and Red ,Green, Blue (RGB) images of various intensities. These image datasets are available publicly which are DIARETDB, structured analysis of the retina (STARE) , and digital retinal images for vessel extraction (DRIVE). These databases make it possible to obtain normal and abnormal retinal images.

4.3 Eye-associated abnormalities.

Eye-related abnormalities can be broken down into two primary classes, the first group is classified as Retinopathy, Conjunctivitis, Bepharitis, and Acute Glaucoma. The second group is classified as diseases associated with lifestyles, such as Hypertension, Arteriosclerosis, and Diabetes.

a) Diabetic retinopathy

Diabetic Retinopathy (DR) is a disease in which the retina is affected by diabetes, and if they are not dealt with correctly, it may end up causing vision loss. Ophthalmologists have agreed that thebest treatment for this condition is early detection and treatment (Rahulkar, A.D., Randive, S.N., and Senapati, R.K., 2020). DR moves forward in four different methods, namely Mild-Non Proliferative Diabetic Retinopathy (NPDR) which is also known as microaneurysms, moderate non-proliferative

retinopathy means obstruction of some retinal vessels, Severe Non-proliferative Diabetic Retinopathy (a greater number of vessels are jammed, which deprives the retina of the blood supply and results in the abnormal growth of new blood vessels), and Proliferative Retinopathy (it may lead to retinal detachment). This typically affects both eyes.

b) Cataract

A Cataract is another important cause of blindness in the world, and the main cause of visual impairment in India. Because of the variety of causes, it can be developed at any stage either it is at the time of birth. In India, Cataract is thought to be responsible for 50 to 80 percent of bilateral blind people in the country. The total number of people suffering from Cataract is expected to reach 1.7 billion by 2050.

c) Glaucoma

Acute Glaucoma is an eye abnormality that can damage your optic nerve and causes blindness. There are two main classes, one is Open-angle Glaucoma and the other is Closed-angle Glaucoma. The open-ended angle is an eye disorder that progresses slowly over time. This is why it is referred to as a "sight thief". The closure of the angle can be sudden and painful.

d) Age-related Macular Degeneration (AMD)

It is an eye abnormality associated or connected with aging, which leads to acute and centralized eye damage. It damages the central part of the retina, i.e. macula, enabling the eye to see small details. The two main classes of AMD are - Dry and wet. Wet AMD develops when abnormal cells start to form below the macula, causing blood or fluid to leak out.

5. Problem Statement

Retinopathy is one of the important causes of vision impairment globally. Around the globe, more than 2.2 billion population are visually impaired, and more than a billion are forced to live in unpreventable or unavoidable conditions simply because they cannot access the support they needed. Vision loss could have been prevented or remains untreated in at least 1 billion or almost half of these cases.

- The main focus of this research is to utilise Image Processing and Deep Learning techniques to analyze and process the retinal fundus images for the classification and detection of retinal image sequences.

- Therefore, deploying suitable medical image processing techniques to extract the relevant features, transformation and selection techniques to articulate an expressive feature vector and build an improved model for retinopathy to detect the patterns in retinal images aiding retinopathy detection, with less processing time , accuracy and precision rate.

- The predictive tool helps in emergence of deep learning techniques to process fundus images quickly – and as accurately – as manual screening. Most importantly, it reduces the time taken for the whole process.

6. Research Objectives

Based on literature grilled during the initial phase of the research work, the following objectives are being identified in the light of challenges already stated in the previous sections:

In such a manner, the following objectives are:

1. To study and understand different techniques along with their applications in disease detection.

2. To examine the grading level & lesion detection of different retinopathy diseases in retinal images.

3. To design and implement a novel computational approach to detect different retinopathy diseases.

4. To evaluate, validate and compare the performance of the proposed model on various criteria (less processing time, accuracy, and precision rate) in retinopathy detection.

7. Research Methodology

To achieve the above research objectives different deep learning techniques are used to classify a suitable level of disease in retinopathy. For acquiring suitable result; each uses a pre-

labeled dataset to learn about image representation. For that following approach are shown in Figure 5. are:

1. The first phase of the research involves data collection(images) that are obtained from external sources (publicly available dataset) and pre-processing.
2. Then extracted features will be combined with the lesions that help in performing the grading process. The resultant feature extracted image data will be classified into linear and non-linear classes.
3. Then the classified image will be trained to obtained the severity of the different retinopathy diseases.
4. Evaluate the process and required hybrid algorithm will be designed.
5. Resultant algorithm will detect the suspected individual.

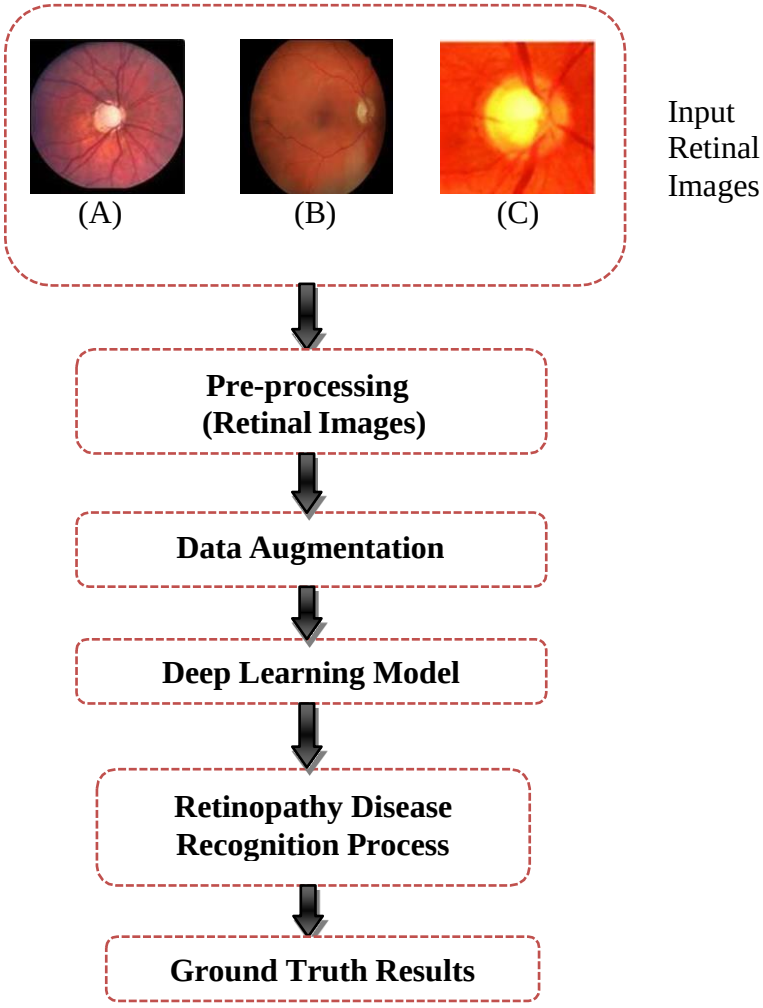

Figure 5: Proposed Methodology

8. Expected Outcome of the Study

i. A general structure would be designed for the extraction of digital patterns from the collected data set.

ii. Development of a model that would be able to identify an individual with any type of retinopathy or not.

iii. Development of an improved model that can examine the grading level & lesion detection in retinal images using Deep Learning model.

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